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Phonon cooling and lasing with nitrogen-vacancy centers in diamond

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Diamond has emerged as a promising material for quantum applications, due in part to its optical and mechanical properties and in part to its addressable quantum defects. In this talk I will discuss the deformation potential interaction between nitrogen-vacancy (NV) centers and isolated mechanical modes in diamond nanostructures. Even on a single phonon level, this coupling can lead to significant shifts of the electronic and spin levels of the defect center and could provide a new tool to access and manipulate the quantum state of macroscopic mechanical systems. I will describe applications of this coupling mechanism for actuation (lasing) and ground state cooling of diamond nanoresonators and show how the combination of these schemes leads to PT-symmetry breaking phase transitions in coupled resonator arrays with engineered loss and gain.